noticed in these columns. The observations secured during the year will, when worked up, afford an accurate knowledge of the times of the tides and of the turning of the tidal streams in the lower St. Lawrence. Many new observations of the tide-levels at different stations have also been obtained.

A METHOD for the preparation of amides from the corresponding aldehydes, which appears to be of general application, is described by Messrs. Pickard and Carter in the April number of the *Journal* of the Chemical Society. The aldehyde dissolved or suspended in water is shaken with a slight excess of ammonium persulphate and a certain quantity of lime, and after the reaction is over there is no difficulty in separating the amide in quantities amounting to 30 to 40 per cent. of the aldehyde taken. The method also lends itself to the preparation of alkyl-substituted amides, potassium persulphate being substituted for the ammonium salt and the alkylamine being present.

THE following species, among others, have been taken at Plymouth recently by the Marine Biological Association:—Mollusca: *Æolis aurantiaca, Gastrochaena modiolina.* Crustacea: *Achaeus Cranchii.* Polychæta: *Magelona papillicornis, Owenia fusiformis, Scalisetosus assimile.* Echinoderma: *Ophiocnida brachiata.* Hydrozoa: *Heterocordyle Conybeari, Syncoryne Loveni.* The pelagic fauna is increasing in richness and variety. The following have been taken:—Medusæ: *Amphicodon amphipleurus, Margelium octopunctatum.* Crustaceæ: *Podon intermedius;* large numbers of the nauplii and the *Cypris* stage of *Balanus.* Polychæta: post-larval stages of *Arenicola*, Trochospheres and later larvæ of Polynoids and Phyllodocids. Among the species breeding may be mentioned the following:—Crustacea: *Porcellana platycheles, Zantho rivulosus*; several species of *Portunus* and *Stenorhynchus phalangium.* Polychæta: *Myrianida pennigera, Polynoe scolopendrina.* Hydrozoa: *Hydrallmania falcata, Tubularia indivisa, Syncoryne Loveni, Garveia nutans, Diphasia rosacea, Sertularia argentea, Eudendrium ramosum.*

THE additions to the Zoological Society's Gardens during the past week include a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. R. Kirkwood; a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. H. E. Jung; a Common Coot (*Fulica atra*), European, presented by Mr. M. C. H. Hammond; two Picui Doves (*Columbula picui*) from South America, a Red-vented Bulbul (*Pycnonotus haemorrhous*) from India, presented by Mr. D. Seth-Smith; a Huanaco (*Lama huanacos*) from Bolivia, a Tawny Eagle (*Aquila naevioides*) from the Seychelles, a Nilotic Crocodile (*Crocodilus niloticus*) from Africa, four Menobranchs (*Necturus maculatus*) from North America, a West African Python (*Python sebae*) from West Africa, deposited; two Straw-necked Ibises (*Carphibis spinicollis*) from Australia, purchased; a Sykes Oriole (*Oriolus kundoo*), received in exchange.

## OUR ASTRONOMICAL COLUMN.

RUTHERFURD MEASURES OF PLEIADES.—In the *Contributions from the Observatory of Columbia University*, No. 17, Mr. Harold Jacoby furnishes a revised discussion of the series of measures made by Rutherfurd of photographs of the Pleiades group dating from the years 1872 and 1874. The results of the first investigation were published in 1892, and are slightly modified in the present paper. Special reductions have been made to test the possibility of there being systematic errors arising from some form of optical distortion of the object-glass, and comparisons are given of heliometer and photographic measures. The final data are collected to form a catalogue of seventy-five stars in the cluster.

CATALOGUE OF SOUTHERN VARIABLE STARS.—Mr. Alexander W. Roberts has recently published in the *Astronomical Journal* (Nos. 491 492) a catalogue of the positions, magnitudes and elements of variable stars south of $-30°$ declination, reduced from observations made at the Lovedale Observatory with a $3\frac{1}{4}$-inch telescope during the years 1891-1899. In connection with the elements a new departure has been made by considering the epoch of a variable as the first maximum passage during 1900, all the stars being uniformly treated on this plan, except that Algol-variables are reckoned from the first *minimum* passage.

The author finds that the short-period variables have a mean variation of 1 magnitude, while the variation of the long-period class amounts to about 4·0 magnitudes. Reference is made to the possible connection of distinctive colours to the various types of variables.

The catalogue gives particulars of ninety-three variables, copious notes being included in explanation of individual stars.

## ON A SOLAR CALORIMETER DEPENDING ON THE RATE OF GENERATION OF STEAM.

THIS instrument was shortly described in a note[1] which was communicated to the Royal Society of Edinburgh in July, 1882, and it has been fully described and figured in a paper[2] read before the Philosophical Society of Cambridge in December, 1900. In this paper the results obtained in Egypt in 1882 are detailed and discussed.

My object in designing the instrument and in taking it to Egypt was to find out for myself the amount of heat which can be actually collected from the sun's rays at or near the sea-level under favourable conditions. In such circumstances this amount must fall on land and sea alike, and it is the energy of this radiation which maintains the terrestrial economy.

The instrument measures the sun's heat in the same way as the calorific value of other fuels is commonly measured, namely, by the quantity of boiling water which a given quantity of it can transform into steam of the same temperature in a given time. The quantity of the sun's radiation used is measured by the capacity of the reflector which collects it. The reflector concentrates it on the boiler, which is a silver tube with blackened surface, placed in the focus of the reflector. Some radiation is necessarily lost at the reflector and some at the surface of the boiler, because perfect reflectors and perfect absorbers do not exist; but, when the distillation has been started and is in full running, the whole of the heat which penetrates the boiler is used in transforming water into steam, which is retransformed into water in the condenser and measured in the receiver. A portion of the heat of condensation is utilised in raising the feed water to the boiling temperature before entering the boiler.

The details of construction and the dimensions are fully set forth in the paper printed in the *Proceedings* of the Cambridge Philosophical Society. It will be sufficient here to give a brief summary. Fig. 1 shows a general view of the calorimeter mounted equatorially on a tripod. Fig. 2 shows the calorimeter in section. The sun's rays are collected by the reflector $B_1 B_2 B_3 B_4$, which consists of three conical mirrors, $B_1 B_2$, $B_2 B_3$ and $B_3 B_4$, so constructed that rays of light, parallel to the axis of the instrument O P, falling upon these mirrors are all reflected upon the length A B of the axis. A B is the *focal line* of the reflector. The mirrors are carried by arms, as shown, which are attached to the central tube C K. This tube, which is twelve inches long and has a diameter of two inches, is the condenser. It is connected by an india-rubber tube with the glass funnel Z, through which it is filled and by means of which the height of the water in the upper and narrower tube C A can be regulated. The portion A B of this tube is the boiler. It is of silver, blackened outside, and has a circumference of 37 millimetres. When the instrument is pointed to the sun all the rays which strike the mirrors are reflected upon this surface, which has an area of 18·8 square centimetres. The effective collecting area of the reflector is 904 square centimetres, so that the rays are concentrated 48 fold. The glass funnel Z is set so that the level of the water inside the calorimeter stands somewhere between E and F. F G H is a glass tube or dome which performs the functions of a water-gauge, a steam space and a means of watching the distilling operation with a view to being perfectly assured that there is no priming. The tube G L in the

[1] *Proceedings* of the Royal Society of Edinburgh, 1882, xi. 827.
[2] On a solar calorimeter used in Egypt at the total solar eclipse in 1882. By J. Y. Buchanan, F.R.S. *Proceedings* of the Cambridge Philosophical Society (1900), xi. pp. 37, 74.

axis of the instrument is the steam delivery tube. When everything was cold and the sun's rays were concentrated by the reflector on the tube A B, the water boiled in forty seconds. The steam rises in the glass dome, from which it finds exit through the tube G L. Condensation begins so soon as the steam has passed below the point B, and the water produced is collected at L in a graduated tube. After the distillation has been running for a certain time a considerable quantity of very hot water is collected at the upper part of the condenser, and it slowly rises through the narrow annular space B C to replace the water removed from the boiler by evaporation. The boiler is thus fed with water at the boiling temperature, and when the calorimeter has settled down into steady working, the whole of the heat which reaches the water from the sun is used in *transforming water at its boiling point into steam of the same temperature.* It is essential that the distillation be kept running continuously. If the meteorological conditions are such that the boiling is interrupted, then it is of no use making observations at all.

*Locality.*—Sohag, where the observations were made, lies on the left bank of the Nile, in lat. 26° 37′ N. The expedition

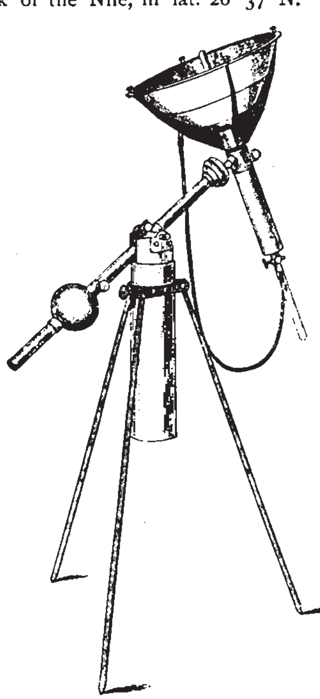

FIG. 1.

arrived there on May 8, 1882, and I was able to begin work on the 11th. As the instrument was new in every way, the work of the first few days was directed towards learning the manipulations and finding out and rectifying defects. Improvements of one kind or another were made every day up to the 15th. On the 16th, 17th and 18th experiments were carried out with the instrument in best working order, and under very favourable conditions. The sun's declination was 19° 22′ on the 17th, so that the mean meridian altitude during the three days was 82° 45′, corresponding to a zenith distance of 7° 15′. The following table gives the sun's zenith distance, as taken from the globe, at every half hour from noon to ± 4 hours, apparent time:—

| Hours | 0 | 0·5 | 1 | 1·5 | 2 | 2·5 | 3 | 3·5 | 4 |
|---|---|---|---|---|---|---|---|---|---|
| ☉'s zenith distance | 7°·25 | 10°·5 | 16° | 22°·5 | 29° | 36° | 42° | 49° | 55°·5 |

The useful time for observation is from 9 a.m. to 3 p.m.

The principal object of the experiments was to ascertain the *maximum* rate of distillation under the most favourable circumstances. This occurred during the forenoon of May 18, when the meteorological conditions were as favourable as they could be. The sun shone steadily in a cloudless sky, and the air was motionless. The shade temperature reached 40°·5 C. in the course of the day.

Between 11h. 35m. 40s. and 11h. 39m. a.m., 5 cubic centimetres of water were distilled, being at the mean rate of 1·501 c.c. per minute at 11h. 37m. 20s. a.m. As the collecting area of the reflector is 904 square centimetres, this corresponds to 16·60 c.c. distilled per minute per square metre. At 11.37 a.m. the sun's zenith distance was 20°. Therefore we know that the sun's perpendicular rays, as received at or near the sea-level, have a heating effect sufficient to evaporate *more* than 16·6 c.c. of water per square metre per minute. Correcting this value for the obliquity of the sun's rays, by the method which shall be indicated presently, it becomes 17·04 c.c. per square metre per minute.

If we take the cubic centimetre of water to weigh one gramme and the latent heat of steam at 100° C. to be 535 gramme-degrees (grs.° C.), the evaporation of 17·04 c.c. water requires 9116 grs.° C. of heat; and this is the amount of heat in ordinary units per square metre per minute which can be collected from the rays of the vertical sun at the sea-level, and can be there utilised. Further, 9116 grs.° C. of heat are equivalent to 3875

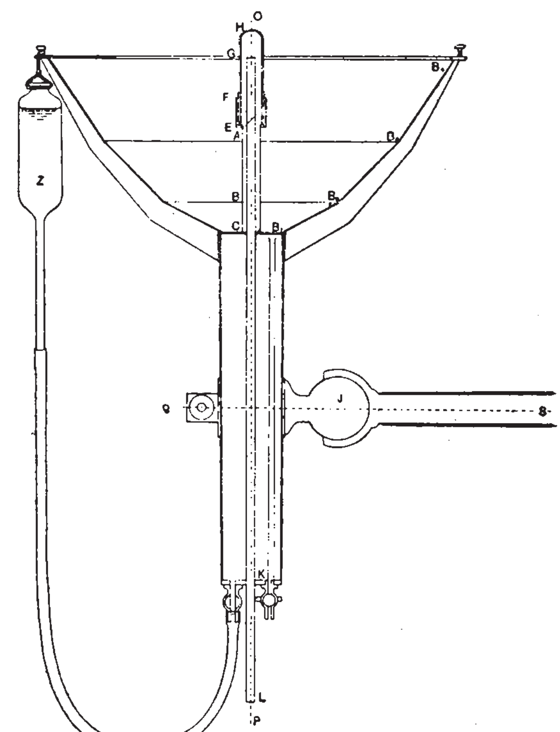

FIG. 2.

kilogramme-metres (kg.m.) of work, so that the working value of the sun's rays as collected by our calorimeter is 3875 kg.m. per minute, or 0·87 horse-power per square metre. No allowance has been made for instrumental imperfections. They certainly exist, but I do not think that more than ten per cent. need be allowed for them. If, however, we increase the working value of the sun's rays from 0·87 to 1·0 horse-power, the allowance is certainly sufficient; and this is probably very close to the true heating value of the sun's rays as they reach the sea-level. Taking the earth's mean distance from the sun's centre to be 212 times the radius of the sun, the radiation emitted by one square metre of the sun's surface is spread over, in round numbers, 45,000 square metres of the earth's surface. Therefore the intensity of the radiation of the sun's surface is equivalent to at least 45,000 horse-power per square metre. This figure, especially when used in connection with so very small a surface as one square metre, conveys no definite idea to the mind. The following consideration may assist in giving definition to our conception. The specific gravity of solid iron at ordinary terrestrial temperatures is about 7·5; therefore one cubic metre of it weighs at the earth's surface 7500 kilogrammes. Taking the force of solar gravity at the sun's surface to be twenty-eight times that

of terrestrial gravity at the earth's surface, one cubic metre of cold solid iron on the sun's surface would exercise a pressure of 210,000 kilogrammes. To lift this mass through one kilometre against solar gravity would involve the expenditure of $210 \times 10^6$ kg.m. of work: and if this amount of work were done in one minute, the engine employed would have to develop 46,667 horse-power.

Further, the heat which is equivalent to $210 \times 10^6$ kg.m. of work is 494,100 kilogramme-degrees (Kg.° C.). When iron is burned in oxygen so as to form the magnetic oxide, the heat evolved is given by the thermochemical equation

$$Fe_3 + O_4 = Fe_3O_4 + 264{\cdot}7 \text{ Kg.}° \text{ C.}$$

Using this constant, we find that the mass of iron which by its combustion would furnish the above amount of heat, would weigh on the surface of the earth 313·5 kilogrammes, and would occupy a volume of 0·0418 cubic metre, or 1 square metre × 4·18 centimetres. Therefore the heat required could be produced by burning 4·18 centimetres of liquid iron on a hearth of 1 square metre per minute. With a supply of oxygen of high tension this would not seem to be an insurmountable task. This is put forward only as an illustration, and in no way as an explanation of the source of the heat of the sun.

With this caution, however, I should like to call attention to a coincidence.

The specific heat of $Fe_3O_4$ is 0·1678, and its molecular weight 232, whence the water value of the gr. molecule is 38·93 grs. The molecular heat of combination is 264,700 grs.° C. Dividing this number by 38·93 we get 6800° C. as the temperature of the $Fe_3O_4$ produced. Adding 273, we have 7073° C. as the absolute temperature which may be produced. In a recent work[1] Scheiner gives 7010° C. as the most probable effective absolute temperature of the sun.

Whilst the maximum value recorded by the calorimeter is the most important for the determination of the sun's heating power, the other values obtained are of use for testing the working of the instrument. The principal disturbing element is wind. During the forenoon of the 18th there was an almost complete absence of wind. We take the observations of that forenoon, neglecting those that show a diminution of intensity as noon is approached, because the sun's heating power cannot diminish as noon is approached. They are collected in the following table. In the first column $a$ is the mean time corresponding to the mean rate of distillation under $d$. Under $b$ we have the sun's zenith distance at this time, and under $c$ the secant of this angle, so that $c = \sec b$. Under $d$ are the mean rates of distillation, in c.c. per minute, for quantities of 20 c.c. collected. Under $e$ are these rates reduced to their value per square metre per minute, $e = 11{\cdot}06\, d$. Under $f$ we have the values of $e$ corrected for the obliquity of the sun's rays. For this purpose the formula given by Herschel in his "Meteorology" is used.[2] It is, using the letters in our table,

$$e = f(\tfrac{2}{3})^c \text{ whence } f = \frac{e}{(\frac{2}{3})^c}.$$

In this equation $\frac{2}{3}$ is the transmission coefficient of the atmosphere; therefore $f$ is really the solar constant expressed in cubic centimetres water evaporated per square metre per minute. Under $g$ it is given in grs.° C. per square centimetre per minute, whence $g = 0{\cdot}0535 f$. As we have assumed $\frac{2}{3}$ to be the transmission coefficient of the atmosphere, and have found the vertical intensity of the sun's rays outside of the atmosphere, we obtain at once its intensity at the sea-level $h = \frac{2}{3} f$. This is expressed in cubic centimetres water evaporated per square metre per minute, and it is practically unaffected by the value which we accept as the transmission coefficient of the atmosphere.

| *a* | *b* | *c* | *d* | *e* | *f* | *g* | *h* |
|---|---|---|---|---|---|---|---|
| a.m. | | | | | | | |
| 8.55 | 44° | 1·390 | 1·264 | 13·97 | 24.57 | 1·314 | 16·38 |
| 9.12 | 39° | 1·287 | 1·306 | 14·43 | 24·35 | 1·303 | 16·30 |
| 9.29 | 35° | 1·221 | 1·326 | 14·65 | 24 06 | 1·287 | 16 11 |
| 10.39 | 20° | 1·064 | 1·405 | 15·53 | 23·92 | 1·280 | 16·02 |
| 11.28 | 10° | 1 015 | 1·447 | 16·00 | 24·16 | 1·293 | 16·18 |

[1] "Strahlung und Temperatur der Sonne." Von Dr. J. Scheiner, Leipzig, 1899, p. 39.

[2] "Meteorology," by Sir John Herschel, Bart., Edinburgh, 1861, p. 10.

The figures in this table show that the values of the heating effect of the rays of the vertical sun, deduced from observations made when the sun was at zenith distances ranging between 10° and 44°, are practically identical. This affords very strong evidence that the calorimeter is a trustworthy instrument.

Reverting to our maximum value with an allowance for instrumental imperfection, if we take one horse-power per square metre as the intensity of the rays of the vertical sun at the sea-level, their intensity outside of the atmosphere is 1·5 horse-power per square metre, using Herschel's value for the transmission coefficient. This is equivalent to 15,882 grs.° C. per square metre, or 1·588 grs.° C. per square centimetre per minute. In round numbers we obtain 1·6 for the value of the solar constant. While it is possible that this value may be a little too low, reasons are given in the paper for believing that the values commonly received, which lie between 3 and 5 grs.° C. per square centimetre per minute, are much exaggerated.

*Observations made during the Eclipse on the morning of May 17, 1882.*

The calorimeter was directed to the sun as soon after totality as possible. At 8h. 34m. the sun was totally eclipsed; at 8.51 the calorimeter was directed to the sun, but no boiling took place. At 8.58 the water began to "sing"; at 9.1 it boiled; at 9.3 it was boiling briskly, but it was not till 9.17 that the first drop of distillate fell into the receiver. By 9.19·5 1 c.c. had passed, and between 9.21 and 9.29·5 5 c.c. passed.

The observations made at this time are collected in the following table. In the first column is the apparent solar time of each observation, in the second column is the volume of distillate collected at that time, in the third column is the mean date of collecting each portion, in the fourth column is the date stated in minutes after totality, in the fifth column is the average rate of distillation in c.c.'s per minute during the interval, and in the sixth column is the percentage of the sun's disc exposed.

| Apparent solar time, A.M. | Cubic centims. collected | Mean date and interval, A.M. | Minutes from totality | Rate of distillation | Amount of sun's surface exposed |
|---|---|---|---|---|---|
| h. m. s. | | h. m. s. | | c.c. per min. | |
| 8 34 0 | 0 | | 0 | | 0·000 |
| 9 1 0 | 0 | | 27 | | 0·329 |
| 9 17 0 | 0 | | | | |
| 9 19 30 | 1 | 9 18 15 | 44 | 0·400 | 0·509 |
| 9 21 0 | 0 | | | | |
| 9 29 30 | 5 | 9 25 15 | 51 | 0·589 | 0·609 |
| 9 36 5 | 10 | 9 32 47 | 58·5 | 0·759 | 0·703 |
| 9 40 55 | 15 | | | | |
| 9 45 45 | 20 | 9 40 55 | 67 | 1·034 | 0·788 |
| 9 47 0 | 0 | | | | |
| 9 51 15 | 5 | | | | |
| 9 56 0 | 10 | 9 51 30 | 77·5 | 1·111 | 0·864 |
| 9 59 50 | 15 | | | | |
| 10 4 5 | 20 | 10 0 0 | 86 | 1·237 | 0·924 |
| 10 5 0 | 0 | | | | |
| 10 8 52 | 5 | | | | |
| 10 14 35 | 11 | 10 9 45 | 96 | 1·146 | 0·987 |
| 10 18 40 | 16 | | | | |
| 10 22 20 | 20 | 10 18 30 | 104·5 | 1·161 | 1·000 |

From this table we see that when distillation has begun, it increases at a much greater rate than the exposed sun's surface. This must be so in the early stages, because we see that it is not till 26 minutes after totality, and when already 33 per cent. of the sun's surface has been uncovered, that the water in the boiler boils, and it takes 16 minutes more before any distillate is collected. Even when 50 per cent. of the sun is exposed, the rate of distillation is only 0·4 c.c. per minute. After this more weight may be attached to the observations, but their numerical significance is not great. Still, they show that useful information could be obtained by arranging for making trustworthy observations during the progress of an eclipse.

In the case of a total eclipse there must be an interval during which the sun cannot keep steam, however large the reflector

may be and however great its concentrating power may be. We have seen that when exposed cold as soon as possible after the total phase of the eclipse, it was twenty-seven minutes after totality before the water boiled. One-third of the sun was then uncovered. It is, therefore, reasonable to suppose that, if the eclipse had happened at noon, so that the first half of it could have been utilised as well as the second half, the sun would have kept steam in the calorimeter, and it would have continued to distil until two-thirds of the sun's surface had been obscured. Then distillation, if it did not cease, would become so slow that its rate would have no value, and fifty-four minutes would elapse before one-third of the sun would again be uncovered, during which the calorimeter would get cold. During this interval *steam must be kept artificially*. This is very easy. The glass tube which forms the steam dome is attached to a metal collar which screws down on a washer. It can, therefore, be easily detached. If, then, the steam tube of the calorimeter be connected by means of an india-rubber tube with a flask in which water is kept boiling, steam can be passed through the calorimeter at the normal rate until it is judged suitable to expose it again to the sun. There is no difficulty about this.

Although quite insignificant as a natural phenomenon, an annular eclipse is better for calorimetric experiments than a total one. On November 11, 1901, there will be an annular eclipse visible in Ceylon. The annular phase will last over ten minutes, and, at its greatest, 0·875 of the sun's disc will be covered. It is fairly certain that the calorimeter used in 1882 would not keep steam through this phase, but a larger reflector might be used. It would be worth while to have a reflector of such a size that steam would certainly be kept through the whole eclipse, especially during the annular phase, when all the radiation is from the peripheral region. J. Y. BUCHANAN.

## THE MINING STATISTICS OF THE WORLD.

IT is impossible to imagine a more concise, more intelligible, or more inexpensive collection of comparative mineral statistics than is contained in the General Report on Mines and Quarries prepared by Dr. C. Le Neve Foster for the Home Office, and it would be difficult to find an editor possessing in a more marked degree the requisite technical knowledge, literary skill and critical acumen for the difficult task of abstracting and collating the heterogeneous official mineral statistics of foreign countries and of rendering them intelligible to the general reader. In many countries the statistics published are imperfect or antiquated. Nevertheless, as regards output, Dr. Le Neve Foster has succeeded in getting together a mass of figures which, in the case of the more important minerals, may certainly be regarded as trustworthy. He has brought into one focus a representation of the present position of the mining industries of the world, and has thus rendered it possible to comprehend the enormous development that has taken place within recent years. The statistics given are of the greatest importance from a commercial point of view. In the United Kingdom alone the value of the minerals raised in 1899 was 97,470,000*l.*, and the vast sums representing British capital invested in mines in all parts of the world will be readily appreciated. Some indication of the remarkable strides made by the mining industry during the past ten years is afforded by the following comparison of the world's output of metals in 1889 and in 1899:—

| | 1889 Metric Tons | 1899 Metric Tons |
|---|---|---|
| Iron | 26,000,000 | 39,136,000 |
| Gold | 182 | 477 |
| Silver | 3,900 | 5,445 |
| Copper | 266,000 | 507,000 |
| Lead | 549,000 | 676,000 |
| Zinc | 335,000 | 511,000 |
| Tin | 55,000 | 74,000 |

In 1899 the world produced 723,239,000 tons of coal, 16,755,000 tons of petroleum, and 12,890,000 tons of salt. Nearly one-third of the coal supply was furnished by the British Empire. The United States supplied nearly another third, and Germany more than a sixth. The remainder was contributed mainly by Austria-Hungary, France and Belgium. The coal production of the principal countries was as follows:—

| | Metric tons. |
|---|---|
| United States | 230,254,000 |
| United Kingdom | 223,627,000 |
| German Empire | 135,824,000 |
| Austria-Hungary | 37,562,000 |
| France | 31,218,000 |
| Belgium | 22,072,000 |
| Japan | 6,761,000 |
| India | 5,016,000 |
| New South Wales | 4,671,000 |
| Canada | 4,142,000 |
| Spain | 2,671,000 |
| Transvaal | 1,938,000 |

In 1889 the United States for the first time outstripped Great Britain as a coal-producing country. In twelve months the British increase was 18,000,000 tons, but that of the United States was 30,000,000 tons. This enormous increase is undoubtedly due to the extended use of coal-cutting machinery. In the United States 23 per cent. of the total output of coal was mined by machinery. Only a little more than 1½ per cent. of the output was so obtained in Great Britain. The path of progress is, therefore, clearly indicated to British colliery owners.

As gold producers the British possessions take the first place, and, thanks to the increased output of Canada and of Western Australia, the British Empire reached a total of 5,475,000 ounces, or more than one-third of the world's supply. One-fourth of the world's salt, and more than half of the tin, are produced by the British Empire. On the other hand, the production of copper, lead, petroleum, silver and zinc is small in comparison with the world's output. The magnitude of the petroleum industry is surprising in view of the fact that its growth has been within the last half of the nineteenth century. The chief producing countries were:—Russia with 8,340,000 tons, the United States with 7,247,000 tons, Austria-Hungary with 325,000 tons, Roumania with 313,000 tons, and the Dutch East Indies with 217,000 tons. The United States has had to cede to Russia the position it so long held as first in the production of petroleum.

In 1899 the Transvaal was the greatest gold-producing country of the world, the output representing a value of 16,273,000*l.* Owing to the war, detailed statistics for 1899 are not available. In Cape Colony the outbreak of the war in October caused a rapid decrease in the output of the coal mines, and eventually stopped nearly all of them. In Natal, again, coal-mining was interfered with, and no official report for 1899 has been received. In Rhodesia, on the other hand, gold-mining made remarkable progress. The output of gold was 65,304 ounces in 1899, whilst in the previous year it was 18,085 ounces. The mining prospects of the country are certainly very satisfactory, more especially as the search for coal is giving most promising results.

The copious references to original sources of information given by the editor in footnotes form a very valuable feature of the report. In this connection it is noticeable that in his capacity of juror at the Paris Exhibition Dr. Le Neve Foster has had access to numerous special reports which, but for his assiduity, would hardly have come to the knowledge of English engineers. The great development of the iron ore resources of Luxemburg during the last thirty-two years, for example, was clearly illustrated in a table shown at the Paris Exhibition. In 1868 the output of iron ore was 691,000 tons, whilst in 1899 it was 5,995,000 tons. At another place in the volume the latter figure is given as 6,014,000 tons, there being apparently a slight discrepancy between the figures obtained by the Home Department of the Grand Duchy and by the German Customs Union, of which Luxemburg forms part. The political classification of the various States is in several cases a matter of difficulty, and has been attended to by Dr. Le Neve Foster with scrupulous care. It is possible, however, that in dealing with Austria and Hungary under one heading, while Sweden and Norway are dealt with separately, he will cause offence to the ultra-patriotic Magyars. Since the compromise between the two States, renewable every ten years, was not renewed in 1897, the Union is merely personal through the Emperor and Apostolic King, and in order to make it evident that Hungary is not a vassal State, the official denomination of the Austro-Hungarian Monarchy is to be preferred to the term Austro-Hungarian Empire used in the report.